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$$x^4+x^2y^2+4ax^2y-2a^2x^2+3a^2y^2-4a^3y+a^4=0,$$

revolves around the axis of y. Find the *companulate* volume generated. If the same portion of the curve revolve around the axis of x, find the *fusiform* volume generated. Also, determine the area of this closed portion of the curve.

41. **Proposed by F. M. SHIELDS, Coopwood, Mississippi.**

A railroad turn-table 100 feet long is balanced upon a pivot in the center of a circular track 100 feet in diameter. How far does a man walk who starts at one end of the table and walks, at a uniform rate, the entire length of the table in the same time that the table makes two revolutions, if the table starts to turn at the same time the man starts to walk?

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MECHANICS

Conducted by B.F.FINKEL, Kidder, Missouri. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

16. **Proposed by A. H. BELL, Hillsboro, Illinois.**

An iron bar 20 feet long and weighing 2,000 lbs, leans against a wall at angles of 30°, 45°, and 80°. Determine the *pressure* upon the floor, and *that* upon the wall.

I. **Solution by F. P. MATZ, M. Sc., Ph.D.. Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.**

Let P_F=the pressure upon the floor, and P_W=the pressure upon the wall, then, if θ be the angle the bar makes with ths vertical wall, we have from *Wood's Analytical Mechanics*, the equations:

$P_F=-W=-2000$ lbs; that is, the floor sustains the whole weight of the bar, and $P_W=\frac{1}{2}W\tan\theta\ldots.(1)$.

According to the conditions of the problem, we deduce from (1) the following results:

For $\theta = 1^\circ$, we have $P_W= 17.455054+$ lbs;
" " $=10^\circ$, " " " $= 176.327696+$ " ;
" " $=30^\circ$, " " " $= 577.350266+$ " ;
" " $=45^\circ$, " " " $=1000.000000+$ " ;
" " $=60^\circ$, " " " $=1732.050800+$ " ;
" " $=80^\circ$, " " " $=5671;280256+$ " ;
" " $=89^\circ$, " " " $=5728.996052+$ " ;

NOTE.—How the *last two* results, and all *succeeding* results to the limit of the quadrant, are to be interpreted, is a question on which Professor DeVolson Wood can *interest* the readers of the MONTHLY.

II. **Solution by EDMOND FISH, Hillsboro, Illinois.**

It must be assumed that the bar is prevented from sliding down by some lateral resistance, either the roughness of the floor, or some object, as a rod or plank laid between the foot of the bar and an opposite wall. Now let a rope be passed from the foot of the bar over a pulley. What weight attached to the rope will relieve the floor of all pressure?

By the Law of Virtual Velocities, Power and Weight are inversely proportioned to their rates of movement in the direction required. In the present case these rates are obviously equal, and the power must equal the weight. Hence the pressure on the floor will be 2000 lbs. for all positions of the bar.

For the pressure on the wall, suppose the bar inclined 30° from the vertical. Its whole weight may be considered concentrated in its center of gravity. Its tendency to move is in an arc whose radius is 10. But only the vertical part of this movement is effective, and this part is expressed by sin30°.

This supposed movement of the center of the bar implies a movement of the upper end in an arc whose radius is 20. But we are concerned only with the horizontal part of this movement and this is expressed by cos 30°. Hence, by the law before quoted, Power (2000 lbs): Weight :: 2cos 30° : sin 30°. (*Twice* cos 30° because R is double).

$$\therefore \text{ Weight or pressure on wall} = \frac{2000\times\sin 30^\circ}{2\cos 30^\circ} = 1000\times\tan 30^\circ.$$

In general the pressure on the wall equals half the weight of the bar multiplied by the tangent of the inclination.

At 30° A is $577\frac{35}{100}$ lbs.
At 45° A is 1000 lbs.
At 80° A is $5671\frac{28}{100}$ lbs.

This problem was also solved by *P. S. Berg and J. F. W. Scheffer.*

17. Proposed by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.

Find the law of density of strings collected into a heap at the edge of a table with the end of the string just over the edge, so that equal masses may always pass over in equal units of times.

Solution by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

A pulverized solid, if piled up, will settle by the force of gravity, to a certain inclination, according to the smallness and smoothness of its particles. Now, a string is practically a cylindric solid of *great* length, *small* cross-sections, and *indefinite* flexibility and compresibility. In passing over the edge of the table, the string will pile into an *approximate* right circular cone. A stream of pulverized solid—an *impalpable powder*, like precipitated B_aSO_4—is practically a *string* of indefinitely small molecular attraction; and such a string will pile into a right circular cone.

Let $AO=r_1$, $CI=m_1$, $\angle CAO=\omega_1$ and δ_0=the initial density of the first *string-cone* formed. Pass a pound (W_1) of string *uniformly* over the edge of the table; then from the cone $AOB-C$, we have

$$W_1=M_1g=V_1\delta_0,=\tfrac{1}{3}\pi r_1^3\delta_0 g\tan\omega_1\,\ldots.(1).$$

Pass similarly a second pound of string; then will be formed the cone